7. February 2000

5 POWER DENSITY CALCULATIONS

Power density calculation near the antenna:

by FCC OET Bulletin 65 (Edition 97-01)   14.10.99 AL

Distance of interest:	3	m
freq=	58	GHz
Ant max dim	0.15	m
Ptx	0.0063 W	
Gant	36.2	dBi
wavel=	0.00517 m	
Number of Tx	1	
Surface power density	1.4282 W/m2	

0.0063 [8] dBm

36.2 dB

Nearfld up to	1.0875 m	
Smax Nearfld	1.0711 W/m2	*break point*

1.797

1/R-region up to	2.61 m
1/R power density	0.3883 W/m2

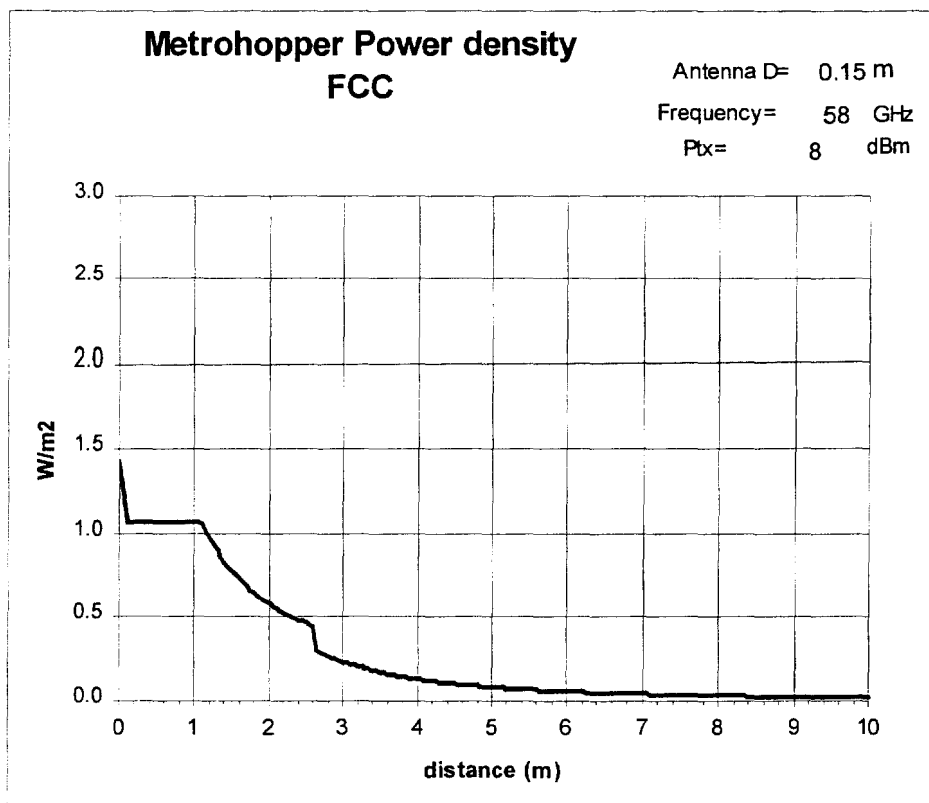*8.700*

0.4463

3.333

Far fld power density	0.2326 W/m2

23.26 uW/cm2

Power density: **0.2326 W/m2**   0.02326 mW/cm2

23.25668 uW/cm2

Maximum allowed value: [10] **W/m2**   FCC-limit > 1,5 GHz

1   *mW/cm2*   *FCC-limit*

Metrohopper Power density FCC

Antenna D= 0.15 m
Frequency= 58 GHz
Ptx= 8 dBm

7. February 2000

Nokia MetroHopper

Radio

Product Overview

C33512.21 D0

NOKIA

NOKIA

Document History

Document	Date	Comment
C33512003SE_00	14 Sep 1998	
C33512003SE_A0	9 Oct 1998	
C33512003SE_B0	12 Mar 1999	
C33512003SE_C0	31 May 1999	

NOKIA

Contents

Chapter 1
About this document

This document is an overview of Nokia MetroHopper Radio and contains the following information:

- an introduction to Nokia MetroHopper

- the features of Nokia MetroHopper

- examples of network applications and site configurations

- an introduction to the Nokia NMS Network Management System and to Nokia Hopper Manager

- construction

- the product structure of Nokia MetroHopper

- technical specifications.

More information on Nokia MetroHopper can be found in the *Nokia MetroHopper User Manual*. For information on related Nokia MetroSite products, see the separate documents for Nokia FlexiHopper Microwave Radio, Nokia MetroSite Base Station, Nokia MetroHub Transmission Node, and Nokia MetroSite Solution.

Documentation is available in print and on CD-ROM. Contact your local Nokia representative for ordering.
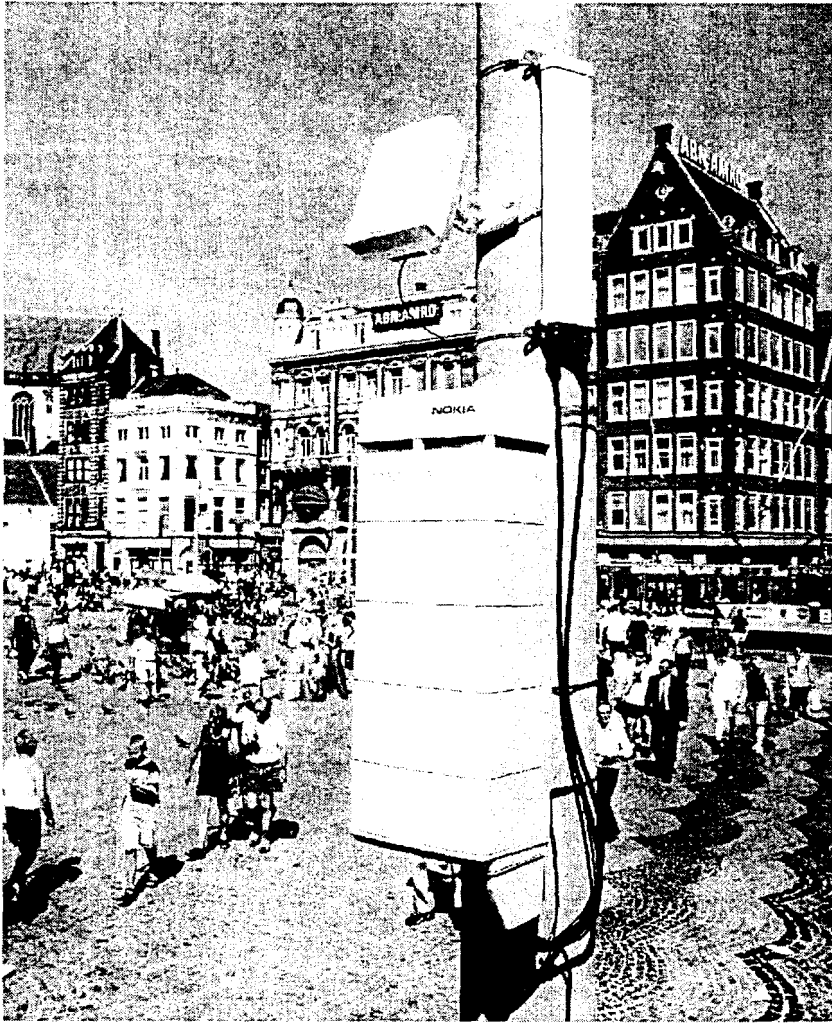
Figure 1   Nokia MetroHopper, wireless access solution for Nokia MetroSite

     NTC C33512003SE_C0

Chapter 2
Introduction to Nokia MetroHopper

As mobile phone penetration and usage of data services continue to grow world-wide, so does the need to expand telecommunications network capacity. This is of particular concern in urban areas, where GSM operators must keep pace with an increasing number of subscribers to remain competitive. With multiple operators from which to choose, today's end-users will not tolerate dropped or blocked calls due to traffic congestion. Network operators are responding to this need with high-capacity cellular networks. A key tool in these networks is affordable base station access for high-density metropolitan areas.

Nokia MetroHopper is an innovative solution for the last-kilometer access in urban networks. This radio can be installed to provide 4 x 2 Mbit/s point-to-point wireless access for Nokia MetroSite Base Station. Nokia MetroHopper can also be used in data, fixed, and residential networks in metropolitan areas where fast access is required.

Synchronised network roll-out

Nokia MetroHopper provides fast access service. Nokia MetroHopper uses the unique 58 GHz frequency band, which does not require co-ordinated frequency planning.

Thanks to this feature of the 58 GHz band, the lead time required to establish base station access is greatly reduced. This can mean elimination of the applying procedure for the frequency license which is typical with conventional radios. There is the possibility for practically immediate connection creation without the delay caused by paper work.

Possibility for faster access service is particularly critical in dense urban areas, where Nokia MetroHopper provides an easy and synchronised roll-out of the base stations and transmission. Likewise, the usage of congested frequency bands or waiting for leased lines can be time-consuming, if not impossible in some metropolitan areas. In addition to saving time, eliminating transmission delays will help to save money that would otherwise be tied up in idle equipment.

Nokia MetroHopper provides easy and quick access for base stations and network terminals without the delay conventionally associated with cellular transmission.

Truly affordable high-capacity cellular access

Nokia MetroHopper provides cost-optimised transmission in metropolitan areas.

Frequency licence fees for 58 GHz radios are typically lower than those needed for conventional frequency bands. In addition, the whole installation process for Nokia MetroHopper is very simple and due to the short installation time the base station can begin generating revenue earlier than with conventional transmission solutions.

Nokia MetroHopper provides high level of service availability essential for high-capacity cellular networks ensuring that operators can securely maintain service and consequent revenues from Nokia MetroSite. Hundreds of Nokia MetroHopper Radios can be installed in one square kilometre, thanks to the unique natural characteristics of the 58 GHz oxygen attenuation band. This, and the automatic channel selection procedure guarantee the best channel for operation.

Finally, due to the very short payback time compared to other means of transmission, Nokia MetroHopper is a unique, affordable, and reliable access solution.

New possibilities for site locations

Nokia MetroHopper is fast and easy to install due to its small size, integrated antenna, and handy optical alignment tool. In fact, the total weight of Nokia MetroHopper is only 4 kg – including the antenna. The rectangular appearance and small size enable Nokia MetroHopper to blend into the metropolitan environment, helping operators to easily develop new types of site locations minimising site rentals and acquisition costs.

Integrated Nokia MetroSite access

Installation of Nokia MetroHopper in the base station is made easy by the range of radio indoor units (FC RRI and FXC RRI) integrated inside Nokia MetroSite Base Station. These plug-in units have redefined the form of access equipment, moving away from the traditional 19-inch-wide racks to minimise installation costs, as additional equipment is not needed on-site. With electricity already provided, connection can be established at Nokia MetroSite in a matter of hours, rather than weeks or months, thanks to the unique capabilities of Nokia MetroHopper.

Chapter 3
Features

Nokia MetroHopper has many unique features in addition to all the essential radio features. This chapter describes these features in more detail.

3.1 Integration into the Nokia MetroSite solution

Nokia MetroHopper is optimised to provide access for Nokia MetroSite capacity solution. Nokia MetroHopper is connected to Nokia MetroSite by FC RRI or FXC RRI plug-in indoor units.

The FC RRI indoor unit is installed in Nokia MetroSite Base Station and has an integrated 2 Mbit/s add/drop capability. For further grooming of transmission capacity, the FXC RRI indoor unit can be installed in Nokia MetroSite Base Station or Nokia MetroHub Transmission Node. FXC RRI features an integrated 8 kbit/s cross-connection and grooming capability with no need for external equipment on-site.

The capacity of Nokia MetroHopper is 4 x 2 Mbit/s providing 48 TRX capacity, or 12 Nokia MetroSite sites. This capacity is enough even for loop protection. No additional network elements are required as the loop protection functionality is already built into the base station with FXC RRI.

Finally, Nokia MetroHopper can be managed locally by Nokia Hopper Manager or remotely by the Nokia NMS Network Management System. At Nokia MetroSite sites, the connection path to the radio is established through the base station or transmission node, removing the need for any additional management connections to the site.

3.2 Unique 58 GHz frequency band

Unique frequency benefits

Nokia MetroHopper is based on reliable 58 GHz radio technology with a channel bandwidth of 100 MHz (ETS 300 408).

The 58 GHz band has the unique natural characteristics of additional oxygen absorption, approximately 10 - 13 dB/km. This attenuation limits feasible hop lengths to less than one kilometre. CEPT administrators have decided that coordination is not required due to the minimal possibility of interference and short hop lengths.

The benefits of the 58 GHz band are:

- Nokia MetroHopper can be installed without any of the conventional delays caused by applying for a licence or waiting for the leased line connection. Naturally, this situation is dependent on the decision of national frequency authorities.

- Sophisticated interference calculations are not needed for the 58 GHz band.

- Administrative paperwork is minimal or eliminated with 58 GHz applications.

- The automatic channel selection procedure manages channel selection allowing Nokia MetroHopper to start operating in a channel with the lowest interference level.

- The ETS 300 408 standard defines channel separation to be 100 MHz. This enables usage of interference tolerant modulation and development of a more robust radio.

- Usage of Time Division Duplex eliminates all subband varieties.

Time Division Duplex (TDD)

Nokia MetroHopper uses a time-division-based duplexing method. In a bi-directional connection each end alternates between transmitting and receiving bursts of data, with the **master** unit defining the exact rate of the bursts. The **slave** unit adapts to the burst rate defined by the master.

TDD application uses the same frequency for both transmission directions. This significantly simplifies the ordering, storage handling, and implementation of Nokia MetroHopper since Nokia MetroHopper is capable of operating on all the channels and subband varieties simply do not exist.

Time division duplexing enables efficient and reliable automatic frequency selection. In the self-regulating 58 GHz frequency band, the channels used by an individual Nokia MetroHopper may be freely selected depending on the decision of the national frequency authorities. With Nokia MetroHopper a single frequency channel of 100 MHz is used in both transmission directions, and therefore Nokia MetroHopper can efficiently detect existing traffic in any of the channels and select the channel with the lowest interference.

Automatic channel selection procedure

Nokia MetroHopper implements self-regulating frequency etiquette in the 58 GHz band. It guarantees that when a connection is established through automatic channel selection, existing traffic can maintain undisturbed transmission service. During commissioning, each available channel is first checked for possible transmission from previously installed equipment and only the free channels are selected as candidates for the new connection.

The automatic channel selection procedure ensures efficient distribution of channel usage in the frequency band. Nokia MetroHopper selects the channel with the lowest level of interference at both ends of a connection, and an optimal density of connections in a given geographical area is achieved.

Burst synchronisation

The maximum connection density in a given area is further increased by the possibility of synchronising the TDD bursts of several Nokia MetroHopper Radios so that each of them transmits and receives the bursts simultaneously. This makes it possible for even extremely closely located Nokia MetroHopper Radios to use the same channel, because the transmission and reception periods do not overlap and therefore no local interference is created.

3.3   Reliable connection

Nokia MetroHopper provides reliable connection and high availability in metropolitan environment.

It can be installed anywhere where line-of-sight is available: on roof tops, in street canyons, in shopping malls. Nokia MetroHopper can be easily installed and it blends well to the metropolitan environment. Even aiming straight down from a skyscraper into a street canyon is as feasible as connecting two sites horizontally at a street corner.

The Nokia MetroHopper outdoor unit (OU) can be installed below roof-top level, because it tolerates vibrations, uses interference-tolerant modulation, and fulfils public safety requirements.

- The OU uses a robust, interference-tolerant MSK-type modulation method.

- Doubly Differential Detection (DDD) provides good tolerance against oscillator phase hits produced by, for example, mechanical shocks or tremble caused by traffic.

- Forward error coding with interleaving improves the overall system performance.

Figure 2   Nokia MetroHopper opens new possibilities for site locations

Versatile maintenance and troubleshooting facilities

Nokia MetroHopper has advanced features for maintenance and troubleshooting.

- The quality of the transmission in the automatically selected channel can be verified with the built-in BER measurement of the indoor unit.

- It features automatic fading margin measurement.

- Incoming signal power measurement can be used for fine-tuning the antenna alignment in special cases when maximum alignment accuracy is needed.

- Far-end and near-end loops can be used for troubleshooting.

- Software can be downloaded from the NMS, which enables flexible updating of new software features and versions.

              NTC C33512003SE_C0

3.4 Fast implementation and commissioning

Implementation and commissioning of Nokia MetroHopper is fast and easy:

- One person can easily carry the small and light Nokia MetroHopper.

- The same alignment bracket can be used for pole, wall, and roof installation.

- Nokia MetroHopper can be adjusted freely both horizontally and vertically, which gives flexibility in site selection.

- Nokia MetroHopper is aligned with an optical alignment tool providing very fast installation. Fine alignment by measuring AGC voltage with a digital voltage meter can be performed in case maximum alignment accuracy is needed.

- Only one visit per site is needed in the installation and commissioning phase.
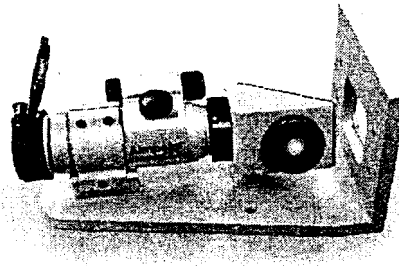
Figure 3   The optical alignment tool

The software of Nokia MetroHopper supports fast commissioning:

- The commissioning wizard in the manager guides the user through the commissioning process enabling quick and error-free commissioning.

- Automatic selection of the radio channel in the 58 GHz band makes sure that existing connections are not interfered with and Nokia MetroHopper starts operating in the best channel, namely the channel with the lowest interference in both ends of the hop. This feature also ensures that optimal density of 58 GHz applications can be achieved in a given geographic area.

- Automatic channel selection decreases the amount of commissioning work by removing the need for detailed frequency planning and fixed channel setting for each radio.

- The number of channels used in the channel selection process can be limited and individual channels can also be allocated manually.

- Nokia MetroHopper automatically provides a commissioning report that includes the number of the selected channel, the interference situation in all available channels, the hop ID, and the TDD master/slave configuration.

- Nokia MetroHopper supports autoconfiguration.

Autoconfiguration

Autoconfiguration is an alternative for end-to-end transmission configuration management in a network which contains Nokia MetroSite sites. Autoconfiguration helps the operator to start gaining revenue sooner and to save in operational costs by eliminating time slot planning, reducing the number and duration of site visits, and reducing the required training level.

Chapter 4
Applications

Nokia MetroHopper provides easy, fast, and reliable 4 x 2 Mbit/s service for sites virtually anywhere. Nokia MetroHopper opens totally new possibilities for site locations. The frequency characteristics of Nokia MetroHopper enable high hop density and short hop lengths.

Typical applications of Nokia MetroHopper are in cellular networks connecting sites together. In addition, Nokia MetroHopper can be used to provide cost-effective connections in:

- residential access applications
- city access applications
- dedicated networks
- PMR (professional mobile radio) systems.

Nokia MetroHopper can also be used to provide temporary voice and data links.

4.1 Network applications

Nokia MetroSite Capacity Solution offers a cost-optimised way to build up to ten-fold capacity of a typical network. In the microcellular layer where most of the network capacity eventually will be built, the innovative Nokia MetroSite Solution and unique characteristics of Nokia MetroHopper allow the development of dense high-capacity networks.
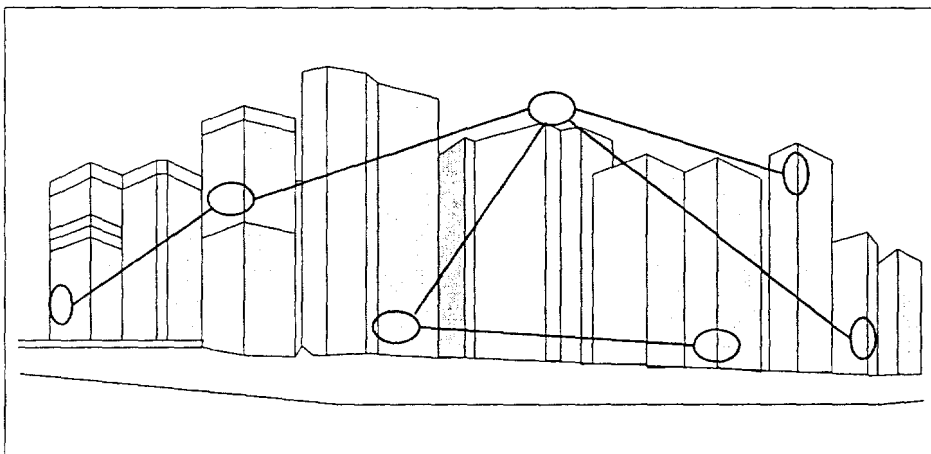
Figure 4   Connecting sites with Nokia MetroHopper

4.2 Site applications with FC RRI/FXC RRI

This section gives examples of different site configurations implemented with Nokia MetroHopper. The site configurations are illustrated in Figure 5.

Nokia MetroHopper at Nokia MetroSite sites

Nokia MetroHopper can be connected to Nokia MetroSite with FC RRI and FXC RRI indoor units. These indoor units are installed in Nokia MetroSite Base Station or Nokia MetroHub. Additional 19" racks are not required at the site, only electricity is needed to supply power for MetroSite BTS.

Tail site, Nokia MetroHopper with FC RRI

Nokia MetroHopper with FC RRI is a cost-efficient way to access base stations at tail sites. FC RRI provides one 2 Mbit/s connection to Nokia MetroSite Base Station. FC RRI supports one Nokia MetroHopper outdoor unit.
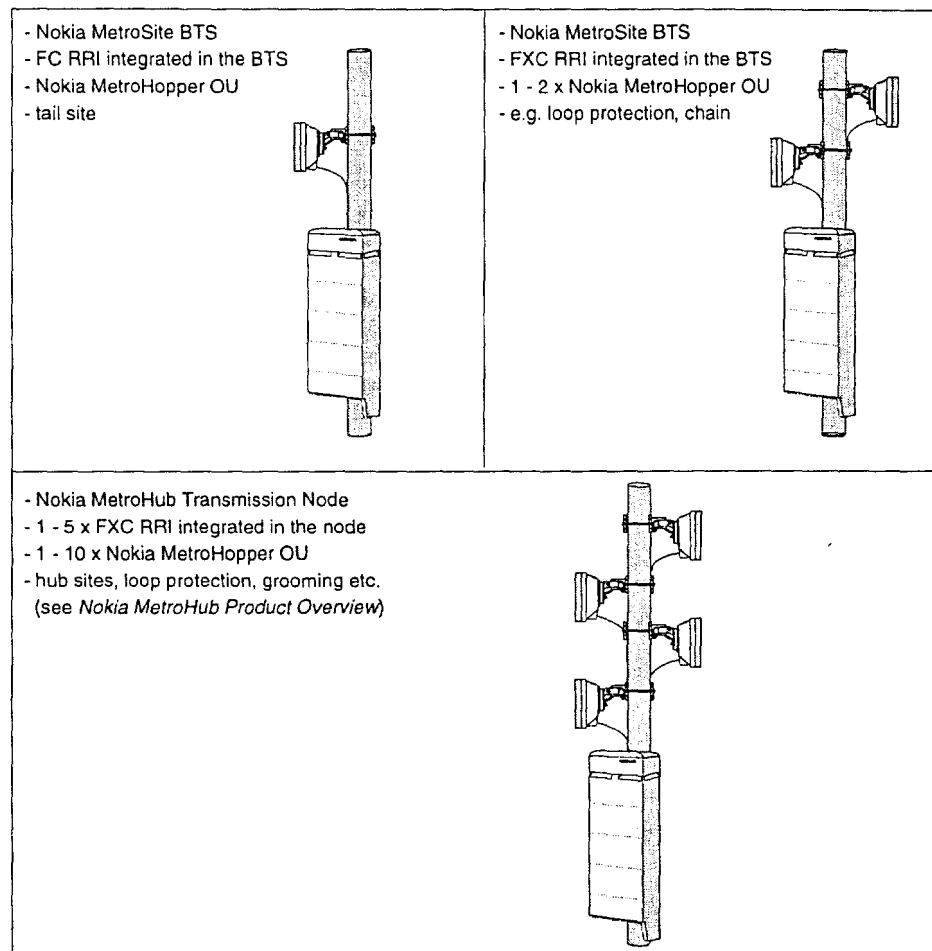
Nokia MetroHopper with FXC RRI

Nokia MetroHopper with FXC RRI is an enhanced way to expand transmission in the metropolitan area. FXC RRI has 8 kbit/s cross-connection capability and supports two Nokia MetroHopper outdoor units enabling various topologies like chains and loops.

In a tail site, one Flexbus interface can be used for the base station access and the other Flexbus interface to provide, for example, fixed access into a building.

## Hub site with Nokia MetroHub and Nokia MetroHopper

Nokia MetroHub Transmission Node supports five transmission units enabling various configurations. Nokia MetroHub provides a cost-efficient way to connect efficiently Nokia MetroHopper Radios to the overlaying transmission network. Nokia MetroHub provides also an easy way to expand transmission capacity. It supports loop protection and provides battery back-up.

- Nokia MetroSite BTS
- FC RRI integrated in the BTS
- Nokia MetroHopper OU
- tail site

- Nokia MetroSite BTS
- FXC RRI integrated in the BTS
- 1 - 2 x Nokia MetroHopper OU
- e.g. loop protection, chain

- Nokia MetroHub Transmission Node
- 1 - 5 x FXC RRI integrated in the node
- 1 - 10 x Nokia MetroHopper OU
- hub sites, loop protection, grooming etc.
  (see Nokia MetroHub Product Overview)

Figure 5   Examples of Nokia MetroHopper with FC RRI / FXC RRI configurations

4.3 Site applications with RRIC

With the RRIC indoor unit, Nokia MetroHopper can be connected to Nokia Citytalk and Nokia Intratalk base stations. This ensures that the features of Nokia MetroHopper Radios can be implemented in existing networks, minimising the amount of additional infrastructure required at existing sites.
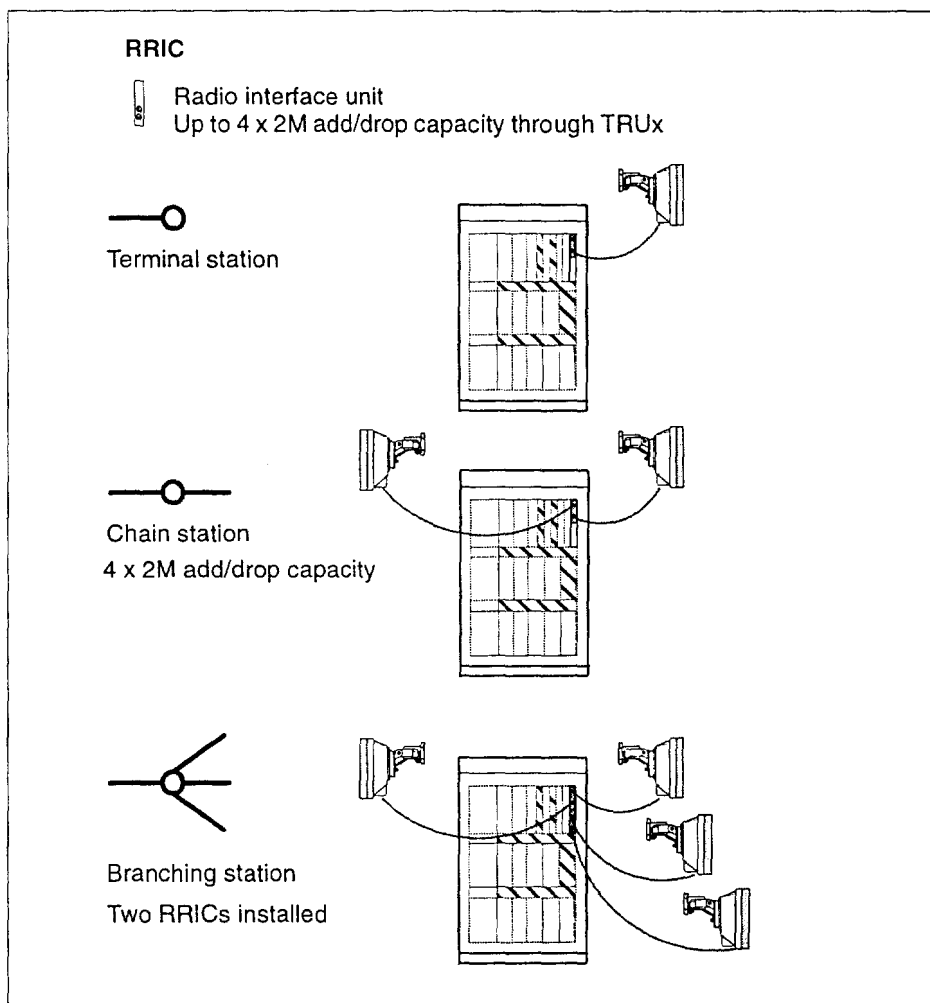
Figure 6   Examples of Nokia MetroHopper with RRIC configurations

      NTC C33512003SE_C0

4.4   Site applications with FIU 19

Nokia MetroHopper can be used in various multivendor environments. With FIU 19 it can be connected to any network equipment through the standard G.703 2 Mbit/s connection. Moreover, the internal 2 Mbit/s cross-connect capability ensures a more reliable access solution, even in non-Nokia networks as it minimises the number of connections between elements.
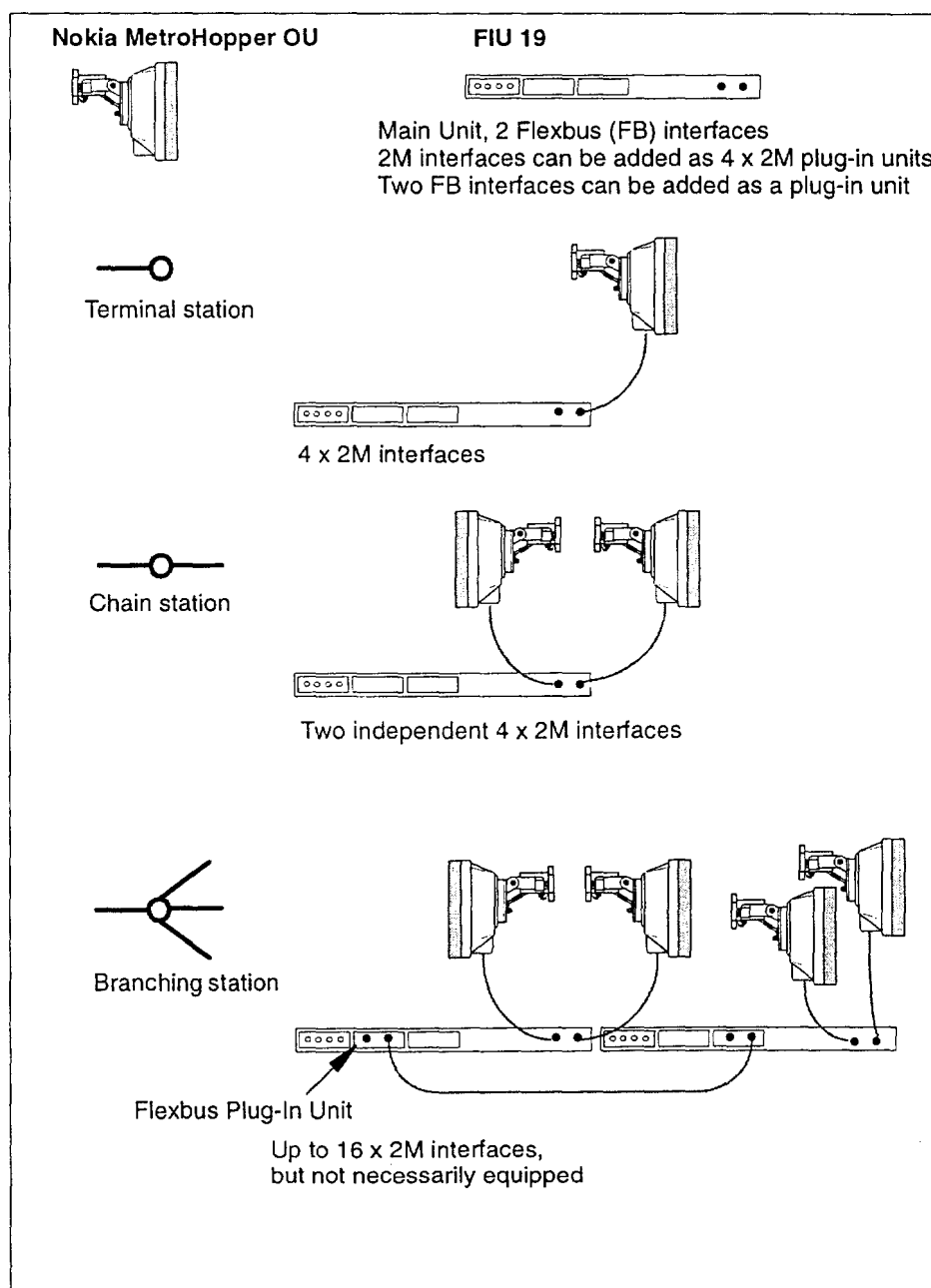
Figure 7   Examples of Nokia MetroHopper configurations with FIU 19

NTC C33512003SE_C0

Chapter 5
Management

This chapter describes management of Nokia MetroHopper with

- the Nokia NMS Network Management System
- Nokia MetroSite Manager and Nokia Hopper Manager

5.1 Nokia Network Management System

The alarm and measurement data on Nokia MetroHopper Radios in a network can be collected centrally with the Nokia NMS Network Management System. The remote control of the radios takes place via Nokia Q1 bus.

The Nokia NMS provides a report of the usage of Nokia MetroHopper Radios in the 58 GHz frequency band. The report includes a unique identity number of each hop, the location of the terminals, the installation date, and the frequency channel used. The report can be submitted to national frequency authorities in case they request information of 58 GHz radios installed in the metropolitan environment.

Nokia NMS incorporates a full range of functions from fault, performance, and configuration management to transmission, trouble, and security management. At Nokia MetroSite sites, all this is provided through the single connection to Nokia MetroSite Base Station or Nokia MetroHub, eliminating the need for additional connections at site.

For more information, please refer to Nokia NMS documentation.

5.2 Managers

Nokia MetroHopper can be managed locally by Nokia MetroSite Manager or Nokia Hopper Manager depending on the indoor unit or application.

Nokia MetroSite Manager is used for managing Nokia MetroSite Base components, including Nokia MetroHopper. For more information, refer to *Nokia MetroSite Base Station Product Overview.*

Nokia Hopper Manager is a PC based software application used for controlling and monitoring Nokia MetroHopper with FIU 19 or RRIC indoor unit.